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T E R A T O G E N E S I S

A brief account of some of the past and present
Theories, with special reference to
Anencephaly.

Being a Thesis for the Degree of M.D.
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by

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PREFACE.

I propose in the first place to give an outline of the chief theories of the causation of monstrosities, then a short account of the anatomical conditions found in Anencephaly with some notes on the clinical history in such cases, and finally to give particulars of two cases of Anencephaly which have occurred in my own experience.

Unfortunately in neither of these latter was a proper dissection of the foetus possible. One was too much damaged in delivering it, and the other was not available owing to the prejudices of the patient's friends.

I may state here that extensive use has been made throughout of Dr J. W. Ballantyne's masterly treatise on "Antenatal Pathology and Hygiene", a work which brings the whole subject under review, and summarises ably and clearly the observations and researches of the numerous workers in this field from the records of the ancients down to the present day.

THEORIES OF THE PAST.

With the history of Teratology and the views held in ancient times as to the cause and origin of monstrosities I shall deal briefly. The literature is extensive and much of it quaint and interesting, but for the most part does not greatly advance our knowledge of the subject, though throwing curious side-lights on other matters. The Ancients never lacked imagination, and since there was hardly any real knowledge to keep their imagination in check it tended somewhat to run riot.

Among the Chaldeans 4000 years ago monstrous births were regarded as portents - sometimes fortunate, sometimes otherwise.

Very generally they were believed to be of supernatural origin - the sport of the gods - a punishment for sins - the work of evil spirits. Astrologers saw in the birth of a monstrosity the result of the positions of celestial bodies, the stars, the planets, the moon, comets.

The Greeks with truer scientific instinct looked for natural causes, and ascribed foetal abnormalities to abnormal conditions of the reproductive apparatus and fluids. Empedocles⁽¹⁾ a Sicilian physicist nearly 500 years B.C. believed that monstrosities arose from seminal

causes, such as excess, deficiency or alteration of quality. During the ensuing 2000 years there were many who followed him. Empedocles does not appear to have attached any importance to menstrual conditions in this connection but other authorities did, some attributing monstrous births to intercourse during menstruation, or to abnormalities of the menstrual blood itself.

Aristotle⁽²⁾ (4th century B.C.) combined the two ideas, believing that terata arose from faults in both seminal and menstrual factors - a conjoint action. Naturally many who came after adopted Aristotle's teaching, embellishing his theory more or less grotesquely according to their period. His definition is worth quoting:-

"The monstrosity is contrary to nature, not contrary to nature taken absolutely, but contrary to the most usual course of nature. Nothing in fact can be produced contrary to that Nature which is both eternal and essential".

He had observed that monstrosities occur with greater frequency in animals giving birth to many offspring at a time, and knew something of the embryonic origin of double monsters in hens' eggs.

Aristotle was in fact the most enlightened teratologist of whom we find any trace in ancient history.

The idea prevailed in various ages and countries that some monsters at any rate were the result of intercourse of mankind with the lower animals, an idea resulting probably from their resemblance to certain animals (aided by a liberal imagination.) It is difficult to understand how ignorance of the fact that different species of animals are not fertile with one another can have survived as long as it did. Even Aristotle believed it, provided the disparity of size and of the gestation period was not too great. As late as the 17th century A.D. writers solemnly considered the question of baptizing the offspring of such unnatural unions. The Hebrews knew better apparently. Leviticus⁽³⁾ provides for the offenders but makes no mention of the possibility of any unnatural progeny.

"MATERNAL IMPRESSION" THEORY.

The belief in the power of maternal impressions to influence offspring in various directions is among the most ancient and widespread. Traces of it appear far back in the dawn of history, and comparatively few even among the educated laity altogether disbelieve it to-day. Jacob⁽⁴⁾ applied the theory practically in his flocks. Empedocles is stated to have remarked that women gave birth to infants resembling statues which during pregnancy they had admired. Galen and many others wrote to the same effect.

Generally speaking the older writers looked upon influences acting through the mother as effectual at the time of conception only, but in the middle ages and later it was held that such influence might act at any time during pregnancy. The theory is obviously one likely to commend itself to the ignorant and imaginative, but would appear not to have been so generally applied to explain monstrosities prior to the 17th century as it was then and later.

The semi-historical instances are very numerous, and on the authority of such diverse

individuals as Pliny, St. Jerome, Galen, Quintilian, Marcus Damascenus Avicenna, Martin Luther. Of all credulous periods that known as the middle ages must always take a high place. The 16th, 17th and 18th centuries shared the credulity of their predecessors and in some respects excelled it. It was even believed that conception could occur by imagination. Ballantyne relates the following⁽⁵⁾:-

Early in the 17th century Magdalena of Auvermont, whose husband had been absent four years, gave birth to a child, explaining the circumstance by a dream in which her husband had been present. After hearing abundant evidence the Parliament of Grenoble declared the child legitimate! This in 1637.

A few writers, however, stand out by reason of their common sense, but they are few and far between. Ambrose Paré⁽⁶⁾ (the obstetrician who introduced podalic version) in 1573 writes:-

"There are some who think the infant once formed in the womb, which is done at the utmost within two and forty days after the conception, is in no danger of the mother's imagination.....

because when it hath got a perfect figure it cannot be altered with any external form of things....."

The British matron of the present day has not yet reached this stage of enlightenment.

Zacchia⁽⁷⁾ in 1621 pointed out that if the maternal impression theory were true most infants were likely to be abundantly marked, and some "spotted like a leopard".

In 1727 Blondel⁽⁸⁾ took the matter up, showing that experience and reason were alike against the popular belief. He pointed out that there were plenty of impressions followed by no marks, on the child, and that children bore marks where there had been no known impression. He ridiculed the whole idea, stating his conviction that the foetus was beyond the reach of the maternal imagination, and observing that as the mother could not mark her own body with her imagination it seemed improbable that she could mark her child's, particularly as there was no nerve communication and no direct blood circulation between the two.

A little later Alex. Monro I. of Edinburgh wrote opposing the theory of maternal impressions on anatomical grounds similar to Blondel's.

In spite of these sceptics the theory still held ground and had distinguished supporters. The 19th century did not settle the question, and it can hardly be said to be finally settled. There has been a growing tendency towards disbelief except perhaps in America - where all things are possible.

In the popular mind at the present time, even among cultured people, it would be difficult to find many who do not believe that it is possible for maternal impressions to affect unborn children. Moreover, a few of the medical profession hold to the same belief.

The Spartan women were required to look upon statues of the strong and beautiful: Dionysius hung a picture of Jason before his pregnant wife and we may presume encouraged her to contemplate it: Galen believed in the influence on offspring of pictures seen by the mother: I have upon my list at the present time a year old child whose beauties and virtues the mother (an educated Englishwoman) regards as due to her having gazed at pictures of beautiful children during her pregnancy.

TRAUMA THEORIES.

The theory that traumatism in some shape or form is a cause of monstrosities dates at any rate from Hippocrates (De genitura) and is probable much older. The trauma might be to the mother, or to the foetus, or might be due to abnormality of the maternal uterus or pelvis, causing pressure upon the uterine contents. Such pressure might be in the nature of a sudden severe injury, or more prolonged and less severe.

The traumatists fall mainly into two groups, those who held that monstrosities arose from what one might call extra-uterine trauma, and those who looked on intra-uterine injury (such as constriction by the umbilical cord or bands of an amnion) as the important factor.

Winslow⁽⁹⁾ early in the 18th century pointed to some of the difficulties of the theory and especially such obstacles as transposition of viscera, polydactyly, etc.

The literature teems with instances of maternal injury followed by delivery of a more or less appropriate monstrosity. In this connection Morgagni⁽¹⁰⁾ will bear quoting. He had

apparently attended the birth of a child with
Spina Bifida:-

"I asked, however, from the mother whether she had ever fallen on her back or received a blow in that part by any other means, or had dreaded or been frightened at any thing, or, in fine, whether she had longed for any thing. All which she immediately and expressly answered in the negative, although afterwards, as the custom is with these weak women, it came into her mind that she had wished for a fig".

The italics are mine.

Tight lacing and other pressures of the kind have been blamed for the production of abnormalities. Cases are cited to prove it. Post hoc rather than propter hoc perhaps.

Some excellent observers who have made a special study of the subject believe in trauma to a certain extent as one cause of monsters. The evidence is not quite convincing. It is necessary to take into full consideration popular credulity, and to allow sufficiently for people's powers of self deception. Given the need for a fall, kick, or blow during the preceding nine

months in order to account for a congenital defect in an infant, how many women are there who will not remember a more or less appropriate injury? Even granting the connection between the trauma and the foetal defect we are only one step on the road to an explanation - the *modus operandi* is as obscure as ever.

Ballantyne⁽¹¹⁾ suggests that it may induce a morbid condition of uterus, placenta or amnion which reacts on the foetus.

Again, pressure of the uterus on the embryo or foetus has been regarded as a factor in the production of abnormalities, especially those of the extremities such as club foot, this pressure being exerted by a contracted or diseased pelvis, or by morbid conditions of the uterus itself. The evidence in favour of the view is chiefly of the 'post-hoc' variety. At first glance it would appear reasonable enough, but on the other hand the negative facts must not be lost sight of. In a large city - Glasgow for example - the number of rickety and deformed and contracted pelvises is considerable: Incarceration of the retro-flexed gravid uterus is not very uncommon:

uteri with fibroids in their walls occasionally become pregnant: pregnancy in a uterus bound down by adhesions is not rare. Indeed in most morbid conditions of pelvis and uterus pregnancy may and does occur (often followed by abortion it is true, but that does not, I think, as a rule affect the question). Yet I am not aware that terata are relatively much more common in the case of such maternal conditions and even if they were other equally good reasons could be adduced to account for them. It may be that such conditions account for a few of the foetal malformations, but the evidence that they are numerous is not by any means clear, and in no case that I know of does it appear conclusive. It is to be borne in mind too as Kellar⁽¹²⁾ has pointed out that hydramnios is a frequent accompaniment of monstrosities.

It is true that in some cases of congenital talipes (varus for example) the feet are in a position similar to that taken up in the uterus before birth.

"It is easy then to understand that in an unusually small uterus this tendency may be exaggerated" or "due to a deficient amount of

liquor amnii" (13); but are not most of these cases of congenital talipes varus due to faulty innervation from the central nervous system of certain groups of muscles?

Foetal abnormalities in ectopic pregnancies are stated to be of frequent occurrence and these are cited as pointing to the adverse influence of pressure. This conclusion is open to criticism in that other morbid conditions present might account for the facts.

Intra-uterine pressure by a tumour or by one of twins on its fellow is a possible factor in teratogenesis. It occasionally happens that one of twins is malformed and sometimes a monstrosity, but there is little to show that when truly monstrous this is due to pressure. More probably it is a vascular or nutritive phenomenon.

That the parts of a foetus or embryo may in certain cases exert a deforming influence on itself is probable, but evidence is lacking that such can produce true terata.

There is some evidence to show that the umbilical cord may be a cause of foetal deformities either by producing pressure of one part of the

body against another or by itself constricting a part. A number of cases of intra-uterine amputation were recorded as far back as the 17th and 18th centuries but apparently not attributed to pressure of the cord. As an illustration of this condition the case published by Watkinson in 1825⁽¹⁴⁾ may be quoted:- The infant was born at the 7th month without a left foot, the foot having been amputated just above the ankle and the stump was not quite healed, the bones protruding. The foot was found in the vagina after birth and also was nearly healed, the bones protruding. It appeared, judging from its size as compared with that of the limb from which it came, to have been separated 2 months previously.

Barzellotti⁽¹⁵⁾ in 1828, was the first to ascribe cases such as the foregoing to the umbilical cord, other authorities maintaining that they were due to constriction by bands of organised lymph; and others again, that they were the result of foetal fractures from external violence; and yet others, that they arose from a morbid epithelial downgrowth from the epidermis.

A glance at the literature of the subject suffices to show that authorities differ very widely, and that though in some of the recorded cases appearances favour constriction by the umbilical cord yet that it is not conclusively proved.

To sum up the trauma theories then, it would appear that though there are now and then cases where the connection between injury and monstrosity appears to be more than a mere coincidence, such cases are rare. It is of course quite conceivable that a given monstrosity may arise from one of several distinct causes. Pleural adhesions may arise from injury as well as from disease. Amniotic adhesions are, as will be seen later, possibly a cause of defective or irregular development of the embryo and might be supposed to originate from injury, from disease, or as a developmental error. All that can be said is that a few cases occur in which injury would seem to be the probable cause of the condition found, but that there is little direct proof of such being the case.

PATHOLOGICAL THEORIES.

Having briefly glanced at the chief traumatic theories of teratogenesis the pathological falls next to be considered. They are of more modern origin than the preceding.

Licetus(16), in 1616, suggested an analogy between syphilitic destruction of certain parts in adults and "monstra mutila".

Morgagni, writing in 1761, attributed anencephaly to preceding hydrocephalus, explaining it by supposing that the pressure of fluid from within acted in the less resisting parts of the cranium. Others supported the view and amplified it, among them comparatively modern authorities of good standing. Against it have been brought forward the arguments that the examination of the base of the skull does not lend support to the theory. There is in anencephaly no such flattening or concavity of the basis cranii as is found in hydrocephalus, and as one would expect to result from internal pressure. Further, the structures on the base of the skull were occasionally found to be in such a perfect state as was hardly consistent with considerable and continued pressure from within. Again, the eyes in anencephalics are often nearly perfect.

The essential parts of the eye are developed from the anterior cerebral vesicle. How, it is asked, can this perfection of the eyes, be squared with complete, or almost complete destruction of the cerebral vesicles? It was also pointed out that the bones of the cranial vault in anencephaly are, as a rule, equally diminished in all dimensions, and looking at the bones of the base the appearance certainly does not give the impression that they have been subjected to an internal expanding force.

Beclard⁽¹⁷⁾ early in the last century held the view that many foetal abnormalities could be traced to dropsical conditions induced by twists of or injury to the umbilical cord, and applied his views to explain acephaly, cyclopia, otocephaly, etc. He was ingenious but unconvincing and later work has shown many of his conclusions to be erroneous.

J. Y. Simpson⁽¹⁸⁾ of Edinburgh considered that foetal peritonitis had been overlooked as a possible cause of congenital malformations, and he attempted to show that the congenital herniae are due to it. He also endeavoured to show that other instances of arrested development have a similar cause, and that the inflammatory changes besides causing arrest of development might lead to subsequent destructive changes.

Guérin⁽¹⁹⁾, a distinguished worker in the field, held that monstrosities arose from local or general disease of the cerebro-spinal system. At first glance the theory seems plausible, but it is not borne out by the known facts. Many tissues and organs in certain cases of anencephaly and placental parasites having no brain and no spinal cord are comparatively normal. It is only late in intra-uterine life too that the central nervous system becomes functional. There are monstrosities also with well developed organs and yet the nerve supply to those organs wanting.

AMNIOTIC THEORY.

A large and important group of terata is associated with amniotic adhesions, and the amnion is by many held responsible as the direct or indirect cause. Some assert that it acts by exerting pressure on the embryo, others that arrested development of the amnion is productive of teratological phenomena, and others again that amniotic disease resulting in adhesions is the important factor.

The amnion may be adherent to the face or cranium of the foetus. Such cases are not rare. In them the vault of the skull is usually very defective, bones, scalp, brain and membranes being in various degrees wanting. Where there are adhesions to the face, that also generally shows defects, especially failure of the facial clefts to close.

The amnion may adhere to the margins of an opening in the abdominal wall and be continuous with peritoneum. In addition to exomphalos there are often other abnormalities. The abdominal opening may extend to and involve the bladder and the symphysis pubis. In such cases the sexual organs are often defective, and imperforate anus or

a cloacal condition may be found. The spine and limbs are often deformed.

Again the amnion may be adherent to the neck or back of the foetus. These, as far as one can judge from the recorded cases, are much less common and are associated with much the same defects as the preceding - viz. facial defects, exomphalos, irregularities of the limbs, fingers, genitals, and spine.

Instead of being adherent to the placental part of the amnion the foetus may be adherent to that covering the umbilical cord. In this variety also the usual types of malformations are met with.

Bands may connect one part of the foetus to another, or one part of the amnion covering the placenta to another. Bands of amnion may be attached to limbs which show deformities, or to amputated limbs or digits. Cases of intrauterine amputation have often been recorded and in some of them amniotic adhesions have been found, but in other cases no evidence of such adhesions is forthcoming. An instance of amputation has already been quoted (page 14).

Associated with amniotic adhesions are found then a great variety of malformations, It is to

be noted that very generally the parts to which the amnion is adherent are markedly abnormal, and also that such fetuses usually show other abnormalities in parts not having amniotic adhesions and more or less remote from them. For example in a recorded case⁽²⁰⁾ of exomphalos, with adhesions of the amnion to the margins of the abdominal opening, anencephaly and spina bifida were also present, but there is no record of any adhesions to these parts.

Many teratologists have reviewed the facts. The adhesions have been looked upon as a result and not a cause of the monstrosity, or rather as a result of inflammation supposed to have given rise to the defect. Montgomery and J.Y. Simpson both regarded these bands as organised lymph - inflammatory adhesions in other words. They may have been so of course, but I cannot find any record of their having examined them microscopically to see. At any rate it has been found that sometimes at least the bands are true amnion.

Others again have argued that as the amnion is formed by up growth of epiblast and mesoblast enclosing the embryo any inflammatory or other morbid change in it might interfere with its proper separation from the embryo and lead to adhesions,

thus accounting for the bands found, and indirectly for the condition of foetus or embryo.

It has been shown experimentally that during incubation of the egg of the domestic fowl monstrosities can be produced in various ways, and Dareste⁽²¹⁾ has found that there was deficiency of liquor amnii and that the amnion appeared to exert pressure upon the embryo. He thought that this pressure arrested some of the processes of development, the injured parts remaining permanently in an embryonic condition whilst the unaffected parts developed normally.

More recent researches, however, seem to indicate that the development of the human embryo differs from that of the lower animals and that the human amniotic cavity may be formed by the breaking down of an epiblastic plug. If such be the case an arrest of development leaving adhesions and bands causing pressure can be more readily understood. It has been found too that the amnion is formed before the embryo has passed through the embryonic stage, and Ballantyne therefore concludes⁽²²⁾ that though disease of the amnion may be a cause of monstrosities it appears more likely that they may be due to pressure from defective development of the amnion.

THE EMBRYONIC THEORY

seeks to account for terata by arrest of development during the embryonic stage. Such arrest may show itself by persistence of an embryonic structure which should not persist, by arrest in the formation of a part, by failure to unite of parts which should unite. Structures which should move may fail to do so, structures which should absorb may not absorb, and others which should develop may not.

The idea is not new. Harvey in his exercises on the Generation of Animals suggested that hare-lip might be due to an arrest of development and the failure to close of normal embryonic clefts.

It will be seen how aptly this theory (as far as it goes) fits many of the conditions requiring explanation and how simply and plausibly with its aid they may be accounted for. It offers too a partial explanation at any rate of abnormalities which do not so readily fit in with other views on teratogenesis, ectopia cordis is for example in this view a failure of the heart to leave its at one stage normal external position and move inside.

Where it is difficult of application, as in symphodia, the intrauterine amputations and a few

other conditions there remain other explanations, and after all there is no very evident reason why all monstrosities should arise from one cause. It is indeed unlikely that they may do so.

That the amnion is instrumental in bringing about some of the developmental defects in the embryo seems probable, more probable in the case of some defects than in others. The result of a large amount of experimental work has been to show that in hatching hens' eggs all manner of monstrosities may be produced by subjecting them during an early stage to physical and chemical changes, such as lowering or raising of temperature, mechanical injury, shaking, electrical or magnetic currents, partial varnishing of the eggs, surrounding them with air containing volatile substances such as turpentine, chloroform, tobacco, injection into the eggs of chemical substances and toxins. It has been conclusively proved that such altered environment during the embryonic stage is capable of producing a large percentage of monstrosities analagous to those found in mammalia, but it has failed to show definitely whether or not the amnion is directly instrumental in their production; and that is the unsatisfactory side of the theory, viz. that there is often not much to show that the

amniotic abnormalities are really the cause of the condition - ie., that they are not, along with the monstrosity, the common result of a cause which has yet to be sought for.

SUMMARY.

The present state of opinion on the subject of teratogenesis may be summarised somewhat as follows:-

That with exceptions terata are probably the result of an injurious environment during the embryonic stage - that is to say that the embryo has been subjected to adverse influences mechanical or toxic (using the word in its widest sense) and that these perhaps act on the embryo through the amnion:

That double monsters and some allied conditions have, in all probability, a pre-embryonic origin and may be conjectured to arise from such causes as fertilisation of an ovum by more than one spermatozoon, presence of two germinal vesicles in one ovum, or irregularities in connection with casting off the polar bodies:

That for such abnormalities as are frequently found to be hereditary a pre-embryonic cause must be sought.

I cannot but think that as our knowledge of this obscure subject increases the germinal group will grow at the expense of the embryonic, and that

many abnormalities now believed to be embryonic in origin will be found to have a germinal origin. There is, to take a single instance, a strongly marked heredity in hare-lip - sufficient to place it beyond the possibility of coincidence, and it is transmissible through both the male and the female. Now, if it be granted that such an arrest of development can be hereditary the cause must lie primarily in sperm or ovum. If one such arrest why not others? Are not many of them closely analogous? Clearly ovum or sperm must sometimes be at fault in an appreciable group of cases - in this hereditary group and in the group where the same malformation occurs in several members of the same family. Is there anything to mark off such irregularities as these from those believed to originate at a later stage and during the growth of the embryo?

On the other hand as has been hinted in an earlier part of this paper it would seem probable that most monstrosities may arise from more than one cause. There can be little doubt that a considerable number of terata are of germinal origin and apparently there is equally little doubt that either ovum or spermatozoon may carry this potentiality. It seems clear too from the

experimental work in teratogenesis that similar defects may arise at any rate in birds from alteration of environment during early embryonic life. It may be too that trauma can produce a parallel result, for although most cases reported with a history of trauma are perhaps rather far-fetched there is a residuum of cases where traumatic origin has a show of probability after reckoning fully with the possibility of coincidence. Also it is quite conceivable that sometimes adhesions of amnion to embryo may cause arrest of development by producing disturbance of nutrition and - perhaps - by exerting pressure. These amniotic adhesions, again, might be conjectured to arise from more than one cause - a morbid, or a traumatic, or a pre-embryonic.

The point I wish to make is that there are facts indicating that all monsters of a given type need not necessarily have similar origins, and further that so far as our knowledge goes there is not much to show that different types of monstrosity may not have distinct causes.

Concerning the teratogenesis of Anencephaly in particular there is not much to be added to what has been already said regarding the subject generally. The malformation is a comparatively

common one among the human race but rare in the rest of mammalia. What this fact signifies it is difficult to see. Ballantyne believes that it results from the difference in the mode of development of the amnion in man as compared with other animals. But this would appear to imply for anencephaly an amniotic cause. Certainly amniotic adhesions to the abnormal parts are frequently found but these may be incidental and not causal. Allowing that they were always present that of itself would scarcely prove an amniotic origin, but since this does not appear to be invariable why regard it meantime as more than an accompanying and perhaps complicating phenomenon? It must not be lost sight of too that however plausible it may seem to attribute malformations and defects of the cranium and brain to the nutritive and pressure disturbances arising from amniotic adhesions, there are generally other abnormalities found in this variety of monster which do not so readily fit in with the theory.

In fine, the origin of anencephalic monsters is as little settled as that of other monstrosities and the fact of their occasional recurrence in families in a manner which appears to preclude coincidence seems to me to be a fact strongly in

favour of a pre-embryonic origin (for some cases at least) and one difficult to explain on any other hypothesis.

The ovum and spermatozoon are cells with marvellous potentialities. We do not understand what the force* is nor how it acts, nor do we know the ultimate structure through which this potential force asserts itself, but we know that any cell or group of cells may suffer great modification of function under abnormal influences mechanical or toxic. We know that the other body cells are subject to such influences and become modified in structure and function in accordance with them, and although the reproductive cells are in some respects a class by themselves there would seem to be no obvious objection to supposing that analogous influences might so modify them functionally or structurally as to produce an abnormal result - a monster.

* The use of the word 'force' here is, strictly speaking, inaccurate. Life is not a force at all in the physical sense and does not come within the scope of Physics. A full discussion of the subject will be found in Sir O. Lodge's "Life and Matter".

This is of course mere speculation - in a region little explored and very difficult to explore, and it is unlikely that any final conclusion will be arrived at until much more is known of that mysterious life-unit the cell, and, in particular the germ cell.

ANENCEPHALY.

I come now to consider a little more in detail the condition known as anencephaly, a fairly well defined type of monstrosity in which more or less of the scalp, cranial vault and brain are wanting. Associated with these defects there is as a rule marked malformation of the bones of the basis cranii and the cervical vertebrae. Very frequently too other teratological conditions are present along with it.

It is a striking and not very uncommon condition. Ballantyne states that in his series of 325 cases of monstrosity and foetal disease anencephaly occurs in 14 per cent.

MORBID ANATOMY.CRANIAL VAULT.

Considerable variations are found in different cases. Usually the parietals are largely absent, the frontals (excepting the orbital part) and the occipital above the inion. Along with this there is more or less complete absence of the scalp and other covering of these bones.

Occasionally the adjacent parietal margins may be chiefly affected leaving an opening in the skull, and the cranial contents partly or wholly outside. The whole vault of the skull may sometimes be lacking - parietals, squamous temporals, frontal plates and supra-occiput with foramen magnum, or these may be represented by imperfectly formed and rudimentary bones projecting from the sides of the base. The degree of deficiency in fact is very variable.

BASE OF THE SKULL.

This generally, but not always, looks backwards; the bones are usually well ossified and often more or less fused together. The squamous portions of the temporal bone together with the tympanic rings are generally absent. There are defects in the middle and inner ears and abnormalities of the wings of the sphenoid and the pterygoid processes. The depression of the sella turcica is frequently obliterated.

BRAIN AND STRUCTURES ON THE BASE OF THE SKULL.

As in the case of the bones of the skull there are great variations and usually the cerebral defects are more or less proportional to those of the skull. All that may be found is a membrane of doubtful origin, vascular in parts, covering the bones. More commonly there is a mass representing cerebral membranes and brain, the membranes difficult to identify and the brain substance softened and hardly recognisable as such. Any part of the brain above the medulla can seldom or ever be recognized. Fragments of amniotic bands may be left attached to the mass lying on the base of the skull.

Some of the cranial nerves may be present, lying on the bones and showing marked irregularities. The blood vessels are also very irregular.

SPINAL CORD.

This shows all grades of imperfection from the comparatively normal to complete absence. As an example of the former the case examined by Drs Waterston and Matthew⁽²³⁾ may be quoted. Their case showed - no nerve tissue above the medulla, what appeared to be haemorrhages in white and grey matter, lateral columns unusually small, absence of the crossed and direct pyramidal tracts, two or three central canals in the cervical region, and a few other minor defects.

THE FACE

often has a peculiar frog-like appearance owing to the eyes being prominent and looking upwards, and to the absence of frontal development. The eyelids are thick, the nose flattened and the ears often twisted. The eyes mostly show more or less marked defects such as absence of the iris, lens, etc., but occasionally are singularly perfect, and to the naked eye may appear normal.

As a rule there is no neck to speak of and the skin passes direct from face to thorax, but there are well marked exceptions. The absence of neck is associated with defects of the cervical vertebrae and a commonly present lordosis (cervical). Not uncommonly some of the facial clefts do not close.

OTHER MALFORMATIONS.

are frequently met with in anencephaly but none that are specially characteristic. Spina bifida is a particularly common accompaniment and as has been stated, failure of the facial clefts to close is not uncommon.

Ballantyne records⁽²⁴⁾ three instances of exomphalos in his 46 cases.

CLINICALLY

cases of anencephalic monsters are not infrequently associated with hydramnios and most if not all of the material symptoms when there are any are due to this cause - are in other words pressure symptoms. Dilatation of the cervix takes place slowly in such cases as a rule. Contractions in an over distended uterus may be very feeble.

The absence of a proper vertex predisposes to malpresentation and to slow dilatation of the cervix. Face presentation is especially apt to occur.

Occasionally the shoulders may be so developed as to give rise to difficulty in delivery and may even require division of the clavicles⁽²⁵⁾.

Instances of oligo hydramnion have been recorded.

Anencephalics are stated to be considerably more often of the female sex. Most statistics show a marked excess of females.

As regards postnatal life, they never live long: generally they can hardly be said to live at all after birth. Still, quite a number of instances are on record of their having lived from

a few hours to a day or two, and it is stated sometimes even longer. Even with complete absence of the brain life may continue for some hours and the child may breathe, swallow, and show other vital phenomena. It seems to be established beyond doubt that this can occur without there being any trace of a brain.

Some Notes on two Cases of Anencephaly
observed by myself.

Case 1.

At the Coombe Hospital Dublin in Sept. 1904. Patient was a multipara aged about 36. There was nothing unusual in the earlier part of the labour and the condition was not diagnosed until labour was well advanced. The face presented and the shoulders were large so that though the maternal pelvis was normal it was found necessary to break up the child.

The whole vertex was wanting and the brain represented by a mass of what appeared to be membranes and blood clot. The eyes were very prominent and there was no neck to speak of. In other respects as far as could be judged from the fragments the child appeared to be well formed. Sex. female.

Nothing that could be elicited in the history seemed in any way to bear on the case.

Case 2.

occured in private practice in Bradford in November 1905. I was summoned the day before labour on account of patient feeling very ill and having a severe headache, and on arrival found that she had had one eclamptic convulsion and was having another.

Patient was a primipara aged 20 and at about full term - a small thin delicate looking girl with an enormously distended abdomen. The eclampsia was treated in the ordinary way by packs, purgatives, chloral, etc., and the fits after she had had four or five ceased for the time being. They recurred next day with the onset of feeble labour pains. As soon as possible delivery was effected. An enormous quantity of liquor amnii escaped and the child which presented by the vertex (if one may call it so) turned out to be an anencephalic monster (female). It resembled the preceding case, but was much smaller, and except for the cranial and cerebral defects appeared well formed. It gave no sign of life. It differed from the usual anencephalic in that it had a fairly well defined neck. The placenta was unusually large and the uterus though it contracted well and there was no

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haemorrhage, was also very large.

Fits recurred in the evening after delivery, but the patient did well.

This combination, eclampsia, hydramnios, monster, is I think a very unusual one.

Nothing specially significant could be gathered in the history. The mother looked very young for her age (20) and was of a degenerate type. The father was still younger - a weedy youth of 18. They had only married when their parents had discovered the necessity for it. No history of alcohol or syphilis.

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